

Jacob Isleib<sup>1</sup>, Rich Shaw<sup>2</sup>, Olga Vargas<sup>3</sup>, Joshua Cheng<sup>4</sup>, Theodore Muth<sup>5</sup>,  
Marissa Theve<sup>1</sup>, Donald Parizek<sup>1</sup>, Michael Margo<sup>1</sup>

<sup>1</sup>USDA-NRCS-Soil Science Division, <sup>2</sup>USDA-NRCS-New Jersey, <sup>3</sup>USDA-NRCS-New York,  
<sup>4</sup>Department of Earth and Environmental Sciences, Brooklyn College, <sup>5</sup>Department of Biology, Brooklyn College

“...Soil Systems are distinct groups of soils or catenas... produced by the interaction of stratigraphy, hydrology, geomorphology, and climate.” Daniels et al., 1999

**ABSTRACT:**

National Cooperative Soil Survey efforts in New York City (NYC) now span almost four decades. The results include multiple high-resolution surveys of parks and watershed areas, a city-wide Soil Survey Geographic database (SSURGO) publication at 1:12,000 scale, and over 100 pedons sampled for full characterization. These pioneering efforts not only characterize the properties and geography of natural soils in NYC open spaces but also human-altered and –transported (HAHT) soils occurring throughout the city. The generic map unit descriptions and other database-driven narratives that accompany SSURGO data (accessible via standard soil survey interfaces like Web Soil Survey) do not sufficiently describe the soil-landscape relationships in NYC. NYC occupies a transition between three physiographic sections (New England Upland, Embayed Coastal Plain, and Piedmont Lowland sections; Fenneman 1946) whose dynamic nature is compounded by Pleistocene glaciation and postglacial coastal influences. Intense urban development and varying degrees of alteration of remaining open space further confuses interpretation of NYC’s soils and landscapes. Given this order of complexity, these relationships are best described using the Soil Systems framework in narrative format, as used in the Soils Systems in North Carolina publication (Daniels et al., 1999). The New York City Soil Systems publication will provide:

- detailed descriptions of recurring groups of soils
- a map correlating SSURGO map units to soil systems/subsystems
- a summary of key laboratory data
- detailed discussion of critical urban soil topics including geochemistry of HAHT soils and human artifacts, soil microbiology and biodiversity in urban soils, green infrastructure, soil rehabilitation and restoration, soil contamination, effects of climate change, and urban soil carbon capture

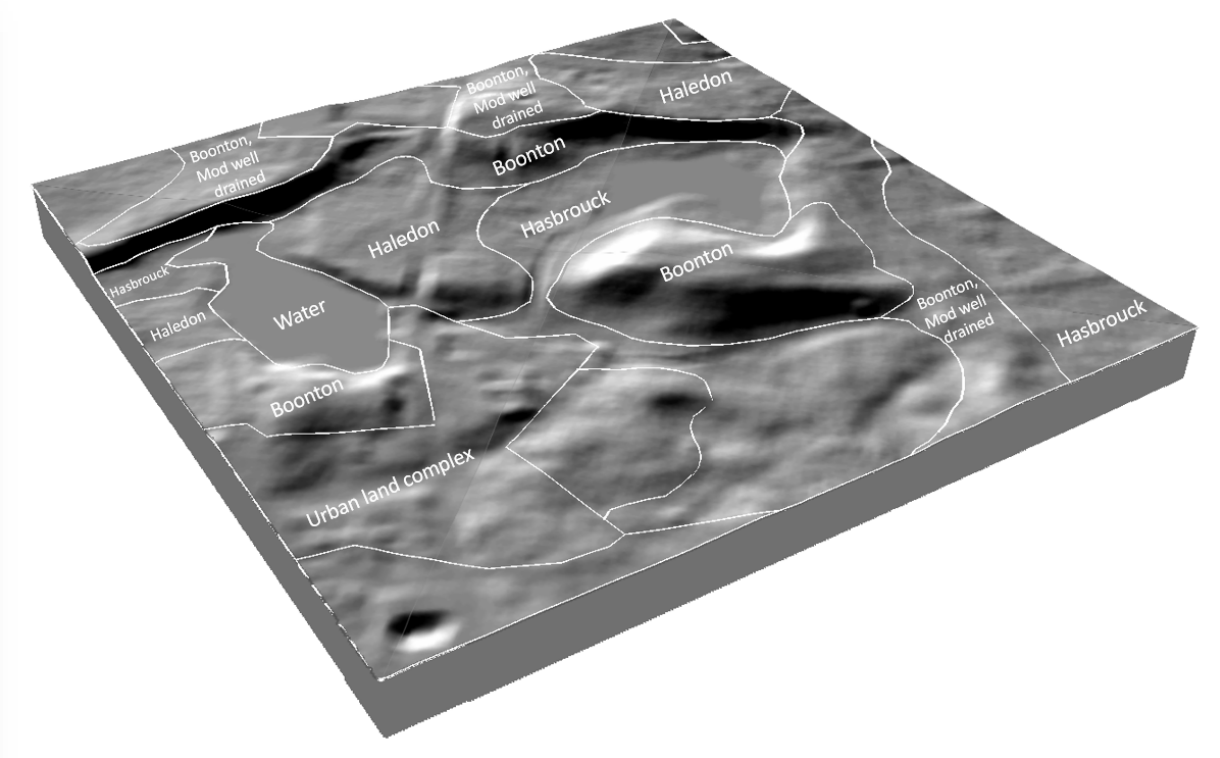
References:  
-Daniels, R.B., Buol, S.W., Kleiss, H.J., Ditzler, C.A. 1999. Soil Systems in North Carolina. Technical Bulletin 314, Soil Science Dept., North Carolina State University, Raleigh, NC.  
-Fenneman, N.M., and Johnson, D.W. 1946. Physiographic divisions of the conterminous U. S. U.S. Geological Survey, U.S. Gov. Printing Office, Washington, DC.

**Examples of New York City Soil Systems diagrams:**

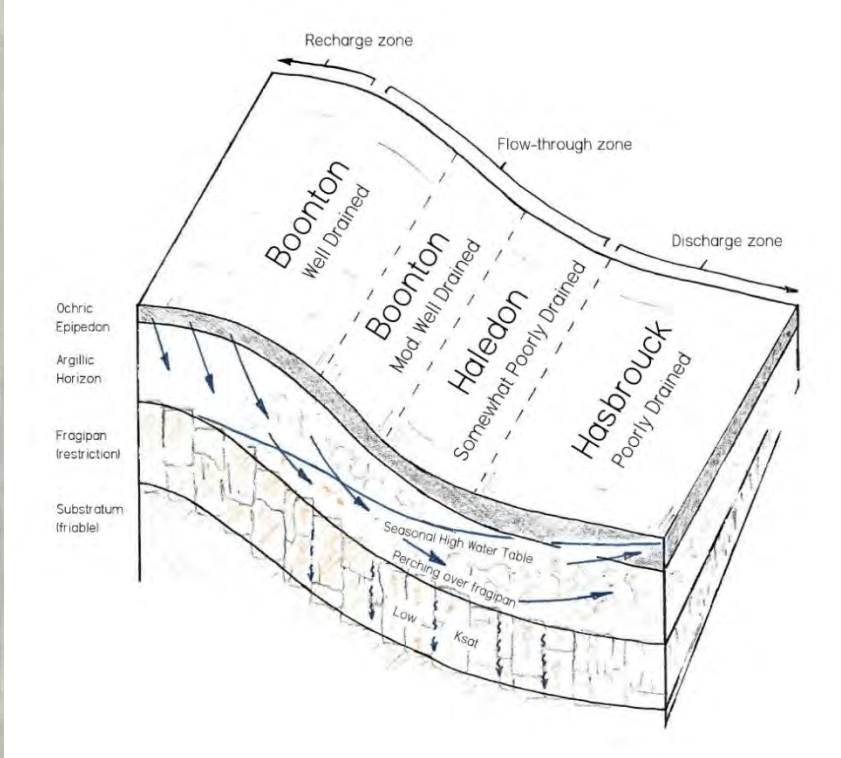
New England Upland region / Red sedimentary and mixed crystalline system / Red fragipan till subsystem---



Boonton soil profile



Boonton/Haledon/Hasbrouck catena block diagram

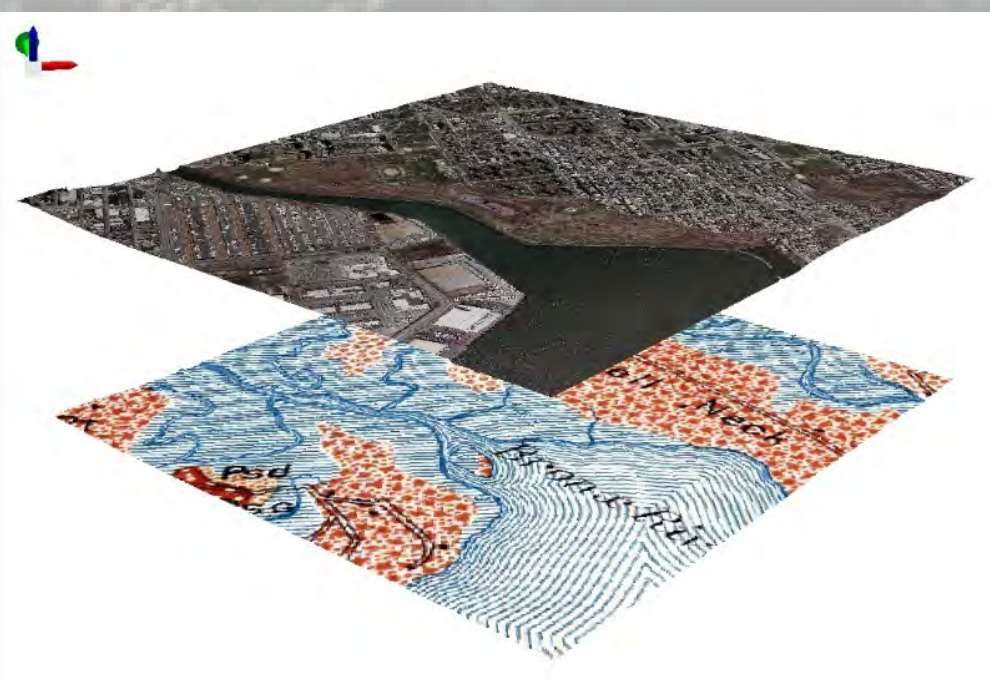


Boonton/Haledon/Hasbrouck catena 3d soil moisture diagram

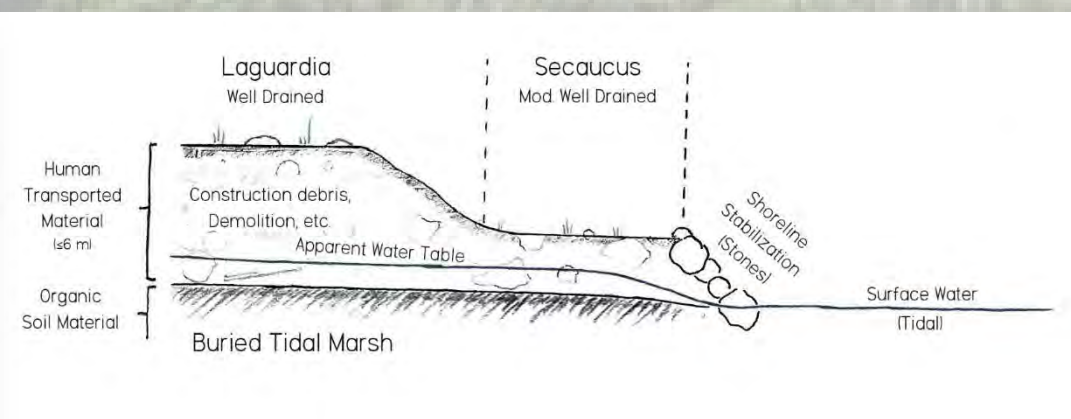
Human-Transported, Human-Altered region / Deep Fill system / Artifact subsystem---



Laguardia soil profile



2010 orthophotography over 1911 surficial geology map, showing extensive filling of former tidal marsh and open water areas



2D high-artifact HAHT soil toposequence

**Excerpt from a New York City Soil System narrative:**

New England Upland region / Brown Mixed Crystalline System / Brown lodgment till subsystem

**Physiography and topography**

The Brown lodgment till subsystem is typically located on drumlins or ground moraines, and nearby drainageways and depressions in the Bronx. Sampling in Central Park (Manhattan) suggest that inclusions of lodgment till occur there, although those areas may have over-thickened solums due to both additions of human-transported material and post-glacial accumulation of eolian material. Drumlins are landforms specifically shaped by the depositional processes forming lodgment till. These landforms typically have longer slope lengths, less steep slopes, and simpler slope complexity than bedrock-controlled hills and moraines associated with melt-out till. Relatively large landform size, oval cross-section, and broad slopes are diagnostic characteristics of drumlin landforms. Additionally, the long axis of drumlins typically parallel the direction of glacial movement. The multiple glaciations that shaped New York City varied in ice-flow direction from NNE/SSW to NW/SE (Sanders and Merguerian 1994). Examples of drumlins with long axis directions matching both of these ice-flow directions can be found in the Bronx, in Van Cortlandt and Pelham Bay parks (Figure 1).

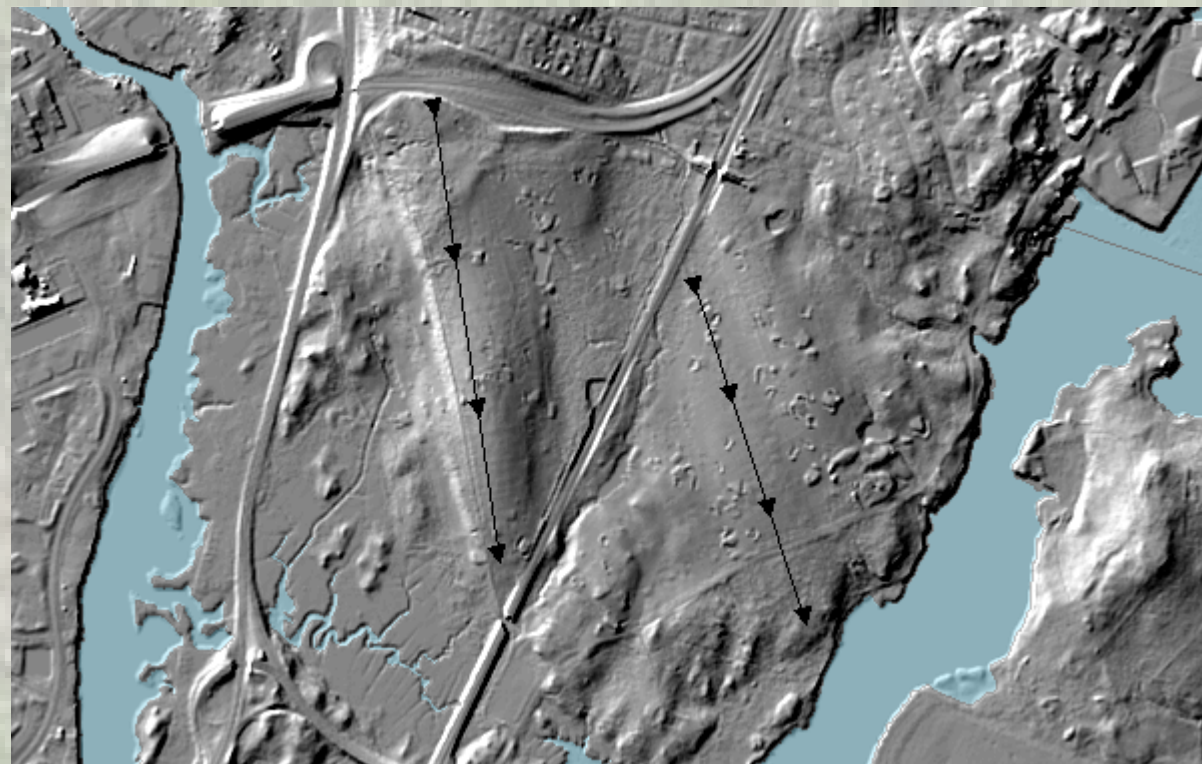


Figure 1. Example of drumlins in Pelham Bay park with arrow lines indicating long axis of landforms, in this case a NW/SE direction

Some bedrock-controlled hills may have deposits of lodgment till over the bedrock. This sequence has been documented in some areas of Central Park in Manhattan.

**Parent Material**

Lodgment till is unconsolidated, unsorted material deposited at the bottom of or beneath a glacier. The weight of ice moving over the deposited material results in compaction of the till, and soils formed in lodgment till typically have observable compacted layers within 1 meter of the soil surface. This is referred to as Densic material in Soil Taxonomy (Soil Survey Staff 1999). Densic material, being a

product of the geologic deposition, is distinguished from fragipan restrictive features by a few key properties. Fragipan features are not inherent to the parent material they form in and develop over time due to pedogenic processes. Further, fragipans found in New York City typically have coarse or very coarse prismatic structural units that show iron depletion on their surfaces, whereas Densic material is either massive or contains plate-like divisions. Densic material maintains a very high bulk density and very firm consistence to great depths (below 2 meters), and fragipan soils typically become friable within a 2 meter depth.

**Soils**

Soils of the Brown lodgment till subsystem are primarily characterized by the presence of a densic contact within 1 meter of depth. The friable solum shows moderate soil development, with bright, saturated matrix colors and weak or moderate soil structure. Rock fragments tend to be less than 35 percent throughout. Soil textures are typically loam, fine sandy loam, or sandy loam in the friable solum, and fine sandy loam or sandy loam textures in the dense substratum. Some densic material may range into coarse textures such as loamy sand. Solum textures ranging to very fine sandy loam or silt loam indicate an eolian influence, which is discussed below under the *Eolian mantle* section.

The typical toposequence of soil series in this subsystem are Paxton (well drained), Woodbridge (moderately well drained), Ridgebury (somewhat poorly drained), and Siwanoy (poorly drained). Note that the Ridgebury soil series is considered both somewhat poorly drained and poorly drained, however in New York City few poorly drained areas of Ridgebury soils were observed. Poorly drained areas in the brown lodgment till subsystem tend to have over-thickened mantles of slope alluvium that characterize the Siwanoy series.

**Eolian mantle**

Some areas of Brown lodgment till subsystem exhibit a...

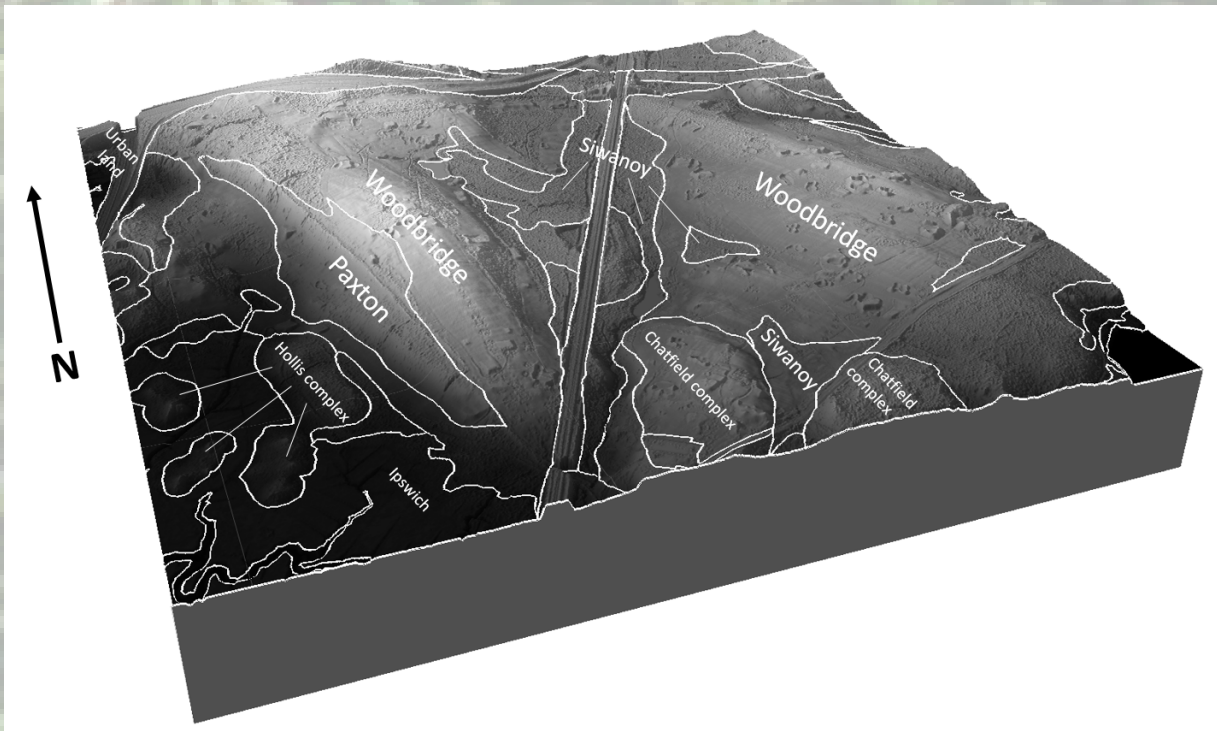


Figure. Block diagram of the Brown lodgment till subsystem on typical drumlin landforms in Pelham Bay Park, Bronx.